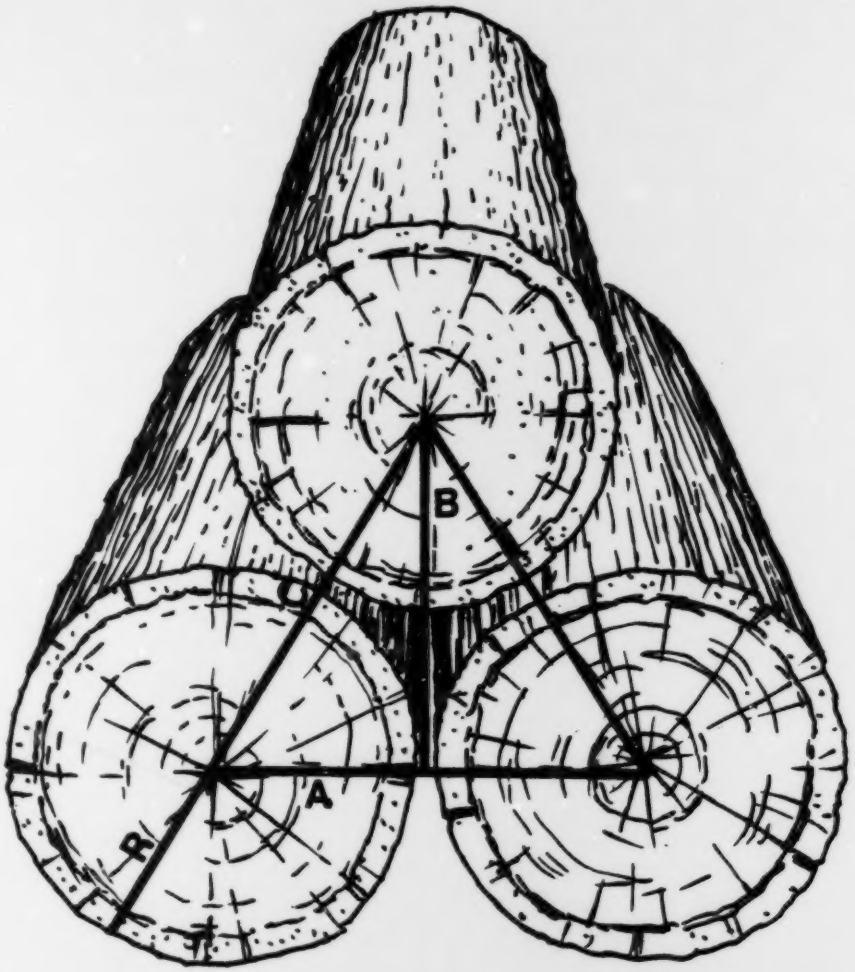
Forest Products Conversion Factors



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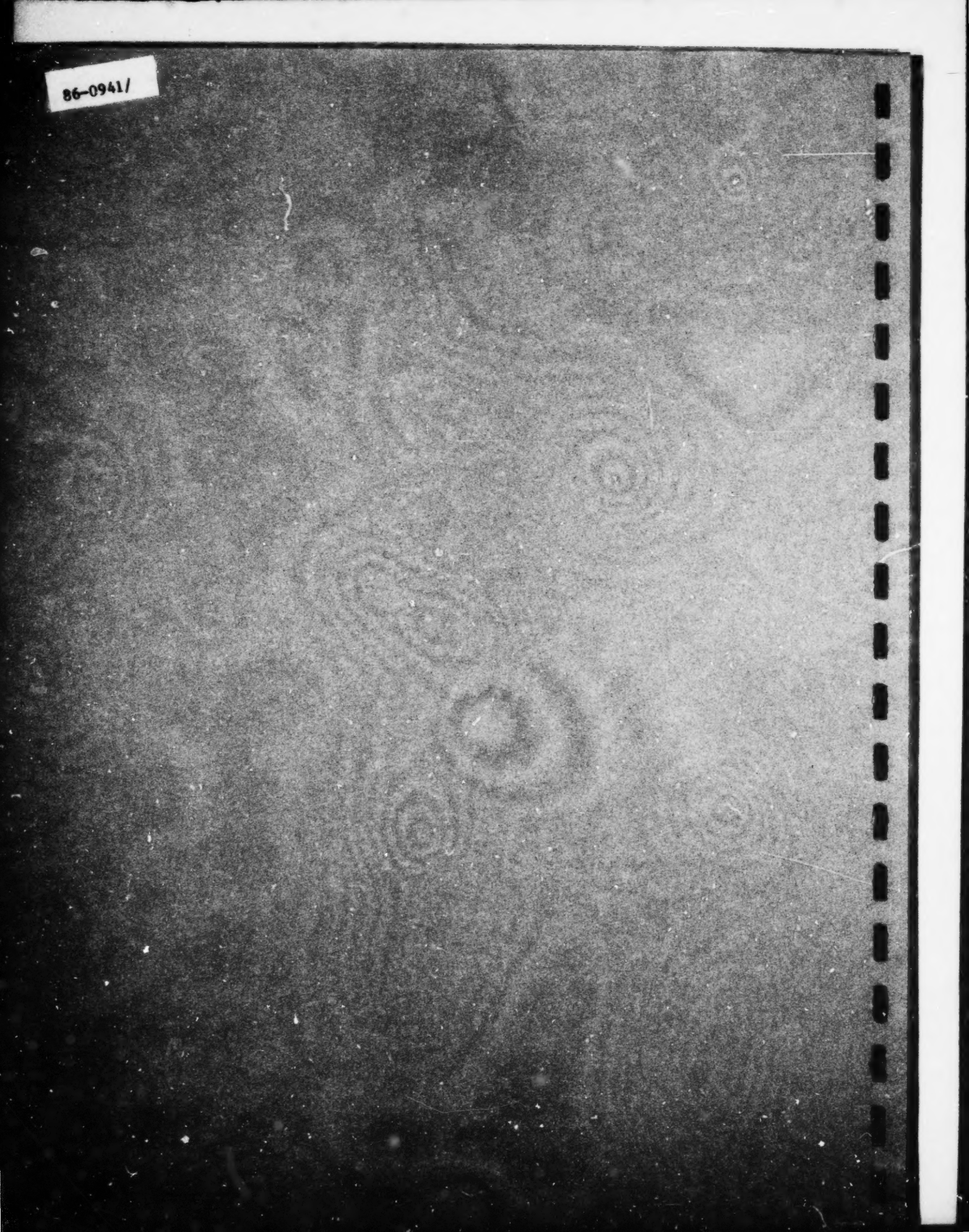
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FOREST PRODUCTS CONVERSION FACTORS:

Background to the Various Forest Product
Conversion Factors Used by the
Alberta Forest Service

1985
EDMONTON

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ABSTRACT

The purpose of this report is to document the tradition and the calculation employed in developing the various Forest Product Conversion Factors used by the Alberta Forest Service.

The forest product conversion factors have evolved from the collection of data and calculation of results from that data or from a long history of adaptation from various sources. In many cases, several approaches have been used to confirm that the resulting factor was reasonable.

Conversion factors for forest products are rarely exact. They are, in fact, usually based upon averages which may change with the conditions that can exist from time to time. It can thus be expected that many amendments will be made to this report in order to keep pace with improved utilization and new developments in the manufacturing process or to explain changes resulting from additional information and calculations.

In 1979 forest measurements were converted to metric units. Although many products are still measured and sold by imperial measure, the volume of these products have been converted to metric. This report has attempted to cover the calculation from imperial to metric when other than the normal straight conversion has taken place.

The report deals firstly with the two basic units of measure, volume and mass, normally used for forest products and how they relate to the individual products.

Recovery factors through manufacturing are covered in the second phase, while the mass-volume relationships are discussed last. It is expected that through time an additional section on energy conversions may be added when more data is available.

TABLE OF CONTENTS

		Page
1.	UNITS OF MEASURE	1
	1.1 Volume	1
	1.1.1 m^3 (Roundwood)	2
	1.1.2 m^3 (Stacked)	2
	Peeled Wood	4
	Sources of Variation	4
	Variation of Solid to Stacked Wood Because of Size	5
	Aspen	8
	Slabs	9
	1.1.3 m^3 (Lumber)	12
	1.2 Mass	15
2.	RECOVERY FACTORS	17
	2.1 Lumber (fbm/m^3)	17
	2.2 Lumber (Per cent of Scaled Volume)	21
	2.3 Railway Ties	21
	2.3.1 Grade No. 1	22
	2.3.2 Grade No. 2 & No. 3 Ties	23
	2.4 Lath	25
	2.5 Sawmill Residue	26
	2.5.1 Woodchip Recovery	28
	2.6 Pulp Recovery	31
	2.7 Plywood Yield	32

Page

3. MASS-VOLUME RELATIONSHIPS 35

3.1 Roundwood 37

3.2 Lumber 38

3.3 Chips 40

APPENDICES

1. CALCULATION OF SAWDUST VOLUMES FROM MILL STUDIES 43

2. ANALYSIS OF WOODCHIP DATA 49

3. (a) Summary of Log Data (1978-79) 57

(b) Summary of Log Data (1979-80 Metric) 57

(c) Summary of Log Data (1980-81 Metric) 58

(d) Summary of Log Data (1981-82) 58

(e) Summary of Log Data (1982-83) 59

4. SUMMARY OF CONVERSION FACTORS 61

LIST OF REFERENCES 65

LIST OF ILLUSTRATIONS

Figure		Page
1.	Types of cubic metre measurements	2
2.	Triangle Theory	6
3.	Measurements taken for slab studies	9
4.	Specifications for railway ties by Canadian National Railways	22
5.	Sawmill study report	28
6.	Edge cuts used for the calculation of sawdust volumes	41
7.	Face cuts used for the calculation of sawdust volumes	42
8.	Factors considered in calculating the volume of the edge cuts	42
9.	Factors considered in calculation the volume of the face cuts	43

LIST OF TABLES

Table		Page
1.	Summary of Check Scaling and Cube Scaling on Stacked Wood ...	5
2.	Ratio of Solid Wood to Stacked Depending on Size	7
3.	Summary of Studies of Solid Wood on Unedged Slabs (1969)	10
4.	Summary of Studies of Solid Wood on Edged Slabs (1969)	11
5.	Lumber Sizes for Imperial Measure and Metric Measure	13
6.	Comparison of Nominal and Actual Sizes	14
7.	Calculation of Average Log Size	18
8.	Fbm/m^3 Ratios by Log Size	19
9.	Board Foot - Cubic Foot Conversion Factors	20
10.	Lumber Recovery as a Percentage	21
11.	Estimated Residue Yields by Sawmill Type in British Columbia	26
12.	Green Wood Requirements Per Tonne of Air Dry Kraft Pulp	31
13.	Plywood Recovery	32
14.	Summary of Weights and Moisture Content from Eastern Canada .	36
15.	Summary of Weights and Moisture Content from Western Canada .	36
16.	Summary of Weight Scales on Coniferous Wood	37
17.	Lumber Weights (lbs./Mfbm)	38
18.	Lumber Weights (kg/Mfbm)	39
19.	Lumber Weights (kg/m^3 [Lumber])	39
20.	Breakdown of Products and By-products Calculated as Percentages	41
21.	Calculation of Lumber and Chip Volumes Using the Alberta Log Rule	51
22.	Breakdown of Products and By-products Calculated by Mill Type	55

1. UNITS OF MEASURE

In the measurement of forest products, two basic units of measure--volume and mass--are used.

The imperial measurement system defined each type of volume measurement by a specific name such as cubic foot, cord or board foot measure (fbm) which related somewhat to the final product or measurement method.

The metric system has defined only one basic volume unit, which is the cubic metre (m^3). However, in some instances, this unit has been further defined to the measurement method such as the case for stacked wood which is indicated by "m^3 (stacked)".

1.1 Volume

A cubic metre (m^3) is the solid volume of wood equivalent to a cube of wood being one metre high, one metre wide and one metre long.

There are three types of volume measurements in forest products: roundwood, stacked and lumber.

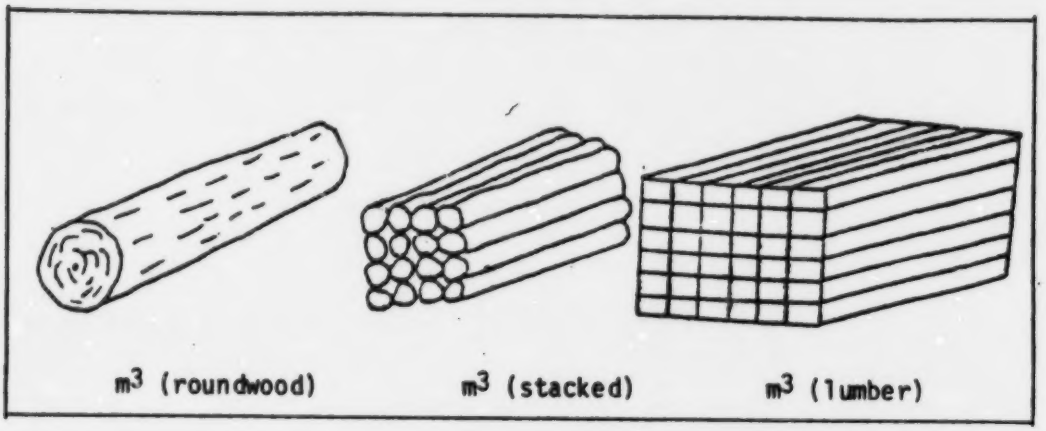


FIGURE 1: Types of cubic metre measurements

1.1.1 m^3 (Roundwood)

In this instance the term indicates that the volume is the solid wood volume of a log or a group of logs. In Alberta, m^3 most commonly refers to the volume of roundwood unless it is clearly indicated otherwise. The volume of woodchips may also be referred to in m^3 units indicating a solid wood equivalent.

The use is therefore similar to the cubic foot measure which was employed under the imperial system.

Relationship of the cubic feet and cunits is as follows:

1 m^3 (roundwood) = 35.315 cubic feet (roundwood)

1 cubic foot = $\frac{1}{35.315}$ = 0.02832 m^3 (roundwood)

1 cunit (100 cu. ft.) = $\frac{100}{35.315}$ = 2.832 m^3 (roundwood)

1.1.2 m^3 (stacked)

A "cord" was defined as a pile of stacked rough wood containing 128 cubic feet of wood, bark and air. This was usually understood to be a pile of wood 4 ft. X 4 ft. X 8 ft.

Although there are many sources of variation (see section 1.1.2.1) it is generally agreed that an average cord of coniferous unpeeled wood contained 85 cubic feet of wood. This was confirmed by cube scaling of check scale wood (See Table 2) and was adapted as the base for Alberta.

The following relationship between the cord and the m^3 roundwood applies:

1 cord = 128 cubic foot wood, bark and air

thus:

1 cord (128 cu. ft.) = 128 X 0.02832 = 3.625 m^3 (stacked)

1 cord = 85 cubic feet solid wood

thus:

1 cord = 85 X 0.02832 = 2.407 m^3 (roundwood)

In the metric system the stacked cubic metre (symbol "m^3 stacked") is defined as "the total amount of wood, bark and air space contained in a stack of roundwood, as determined by its external dimensions, equal to one m^3."

To determine the ratio of roundwood to stacked wood the original assumptions for the cord were applied:

thus:

$$1\ m^3\ \text{(stacked)} = \frac{85 \times 1}{128} = 0.664\ m^3\ \text{(roundwood)}$$

$$1\ m^3\ \text{(roundwood)} = \frac{128 \times 1}{85} = 1.506\ m^3\ \text{(stacked)}$$

Peeled Wood. The amount of bark in a cord varies between 10 and 30 cubic feet. An average of 14.67 cubic feet was adapted in earlier scaling manuals with an adjustment to the volume of 15% required for wood that was peeled.

Using the 85 cubic feet of solid wood and replacing the 14.67 (15) cubic feet which was formerly bark, a cord of peeled wood is considered to have a solid volume of 100 cubic feet and is then related to m^3 roundwood as follows:

1 cord = 100 cubic feet roundwood
thus:
100 X 0.02832 = 2.832 m^3 roundwood

As well, the stacked wood to roundwood relationships may be established for peeled wood as follows:

1 m^3 (stacked) = $\frac{100}{128}$ = 0.781 m^3 (roundwood)
1 m^3 (roundwood) = $\frac{128}{100}$ = 1.280 m^3 (stacked)

Sources of Variation. The relationship of solid wood to stacked wood varies because of several factors. These factors are outlined in the Alberta Scaling Manual.

The relationship may range from a low of 60 cubic feet of solid wood per cord when dealing with small crooked hardwood bolts to a high of

100 cubic feet of solid wood per cord for large straight softwood bolts, according to I.B. Flann in Some Conversion Factors and Related Information.

Variation of Solid Wood to Stacked Wood Because of Size. A summary of cube scaling done on stacked wood check scaled by the Alberta Forest Service is shown below to show the relationship of diameter to solid wood content.

TABLE 1

SUMMARY OF CHECK SCALING AND CUBE SCALING
ON STACKED WOOD

Calculation of Average Cubic Feet per Cord

Year	Cords	Cubic Feet	Pcs	Pcs/cd	Cu.ft./cd
1962/63	1 458.71	121 917.34	50 736	34.78	83.58
1963/64	1 819.23	154 560.07	56 259	30.92	84.96
1964/65	571.43	50 267.04	23 954	41.92	87.97
1965/66	355.01	30 078.28	13 265	37.37	84.73
	4 204.38	356 822.73	144 214	34.30	84.87

Length = 8 ft.
Vol./Piece = 2.474259 cu. ft.
Basal Area = 0.309282 sq. ft. ($BA = 0.005454159D^2$)
Ave. Diameter = 7.5303 in. Ave. cu. ft./cord = 84.8693

Using the theory that the stacked cord is made up of a series of triangles and assuming that all other variables are constant, the variations due to size can be calculated by the following steps:

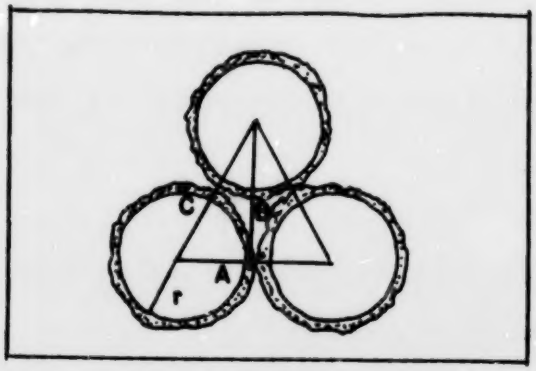


FIGURE 2: Triangle Theory: The concept for which the ratio of solid wood to total area is calculated.

1. The area of a triangle is calculated by taking one half of the base multiplied by the height. In figure 2 this may be expressed as 1/2(A X B). Note that in figure 2, A can be equivalent to a radius (r) and that C can be equivalent to 2r.

2. The area of a triangle can be calculated from a radius once the value of B is solved as follows:

$$B^2 = C^2 - A^2$$
$$B^2 = (2r)^2 - (r)^2$$
$$B^2 = 3r^2$$
$$B = 1.753205r$$

The area of a triangle = r X 1.753205r
= $1.753205r^2$.

3. As the sum of the angles of the three log sectors in the triangle is 180 degrees, the area of wood volume is equivalent to 1/2 the face of a bolt. Using the average bolt (3.309282 sq.ft.) in Table 1, the wood volume in the triangle is thus 0.154641 sq.ft. (22.2683 sq. in.).

4. The average cubic feet of solid wood/cord in Table 1 is 84.8693. Applying the ratio of 128:84.8693, the wood volume (22.2683 sq. in.) is increased to add for air and bark.

$$\text{Total area} = \frac{128}{84.8693} \times 22.2683$$
$$= 33.5851 \text{ sq. in.}$$

5. Using the area formula of $1.753205r^2$, the diameter for air, bark and wood is calculated:

Radius $= \sqrt{\frac{33.5851}{1.753205}} = 4.3768$ in.

Diameter = 2 X 4.3768 = 8.7536 in.

6. The average bolt size in Table 1 is 7.5303 inches. The difference between the two diameters represents the average space required for air and bark.

Air and Bark = 8.7536 - 7.5303

= 1.2233 in.

= 1.2233 X 2.54 = 3.1072 cm

7. The volume of solid wood within the triangle is calculated for each diameter class in Table 2. To determine the triangle size the air and bark space (3.1072 cm) is added to the diameter.

TABLE 2

RATIO OF SOLID WOOD TO STACKED DEPENDING ON SIZE

Bolt Size (cm)	1/2 Solid Wood area (m^2) of Bolt	Triangle Side Length (2r)	Triangle Area (m^2)	Ratio
12	0.005655	15.2426	0.010060	0.562
14	0.007697	17.2426	0.012874	0.598
16	0.010053	19.2426	0.016033	0.627
18	0.012724	21.2426	0.019540	0.651
20	0.015708	23.2426	0.023392	0.672
24	0.022620	27.2426	0.032136	0.704
26	0.026547	29.2426	0.037028	0.717
28	0.030788	31.2426	0.042266	0.728

Aspen. Studies on 149 sample loads of aspen scaled in Alberta indicate that there is a lower ratio of solid wood to stacked wood than for coniferous timber.

While some of this loss can be contributed to thicker bark on the aspen, most of the loss is perhaps due to additional crook in aspen and mechanical loading.

The ratio established as of 1983 is 0.557 m^3 solid wood per m^3 (stacked). The ratio of m^3 solid wood to cords can be calculated as follows:

Deciduous

Solid wood per m^3 stacked = 0.557 m^3 (m^3 stacked)

Cu.ft./cord equivalent = 0.557 X 128 = 71 cu. ft./cord

m^3 solid wood per cord = $\frac{71}{35.315}$ = 2.01 m^3/cord

Slabs. In order to assess the amount of solid wood in a cord of slabs, several studies were done in 1969. The dimensions of the piles were measured by the stacked wood method.

The measurements of the individual pieces were classified into size classes as follows:

Width 4 in., 6 in., 8 in.

Thickness 1/2 in. (under 3/4 in.)
1 in. (3/4 in. to 1 1/4 in.)
1 1/2 in. (1 1/4 in. to 1 3/4 in.)
2 in. (1 3/4 in. to 2 1/4 in.)
2 1/2 in. (2 1/4 in. to 2 3/4 in.)
3 in. (2 3/4 in. to 3 1/4 in.)

The thickness was tallied on the basis that the average was 2/3 of the maximum thickness.

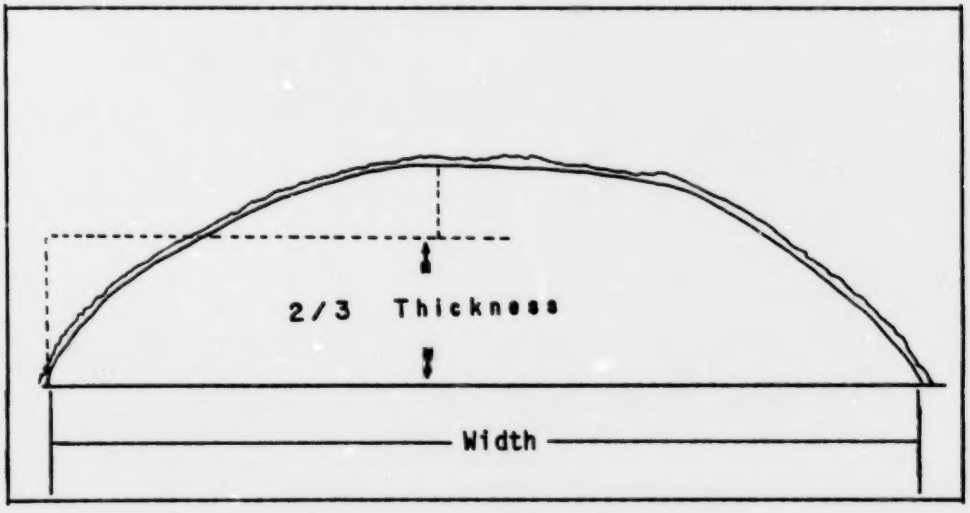


FIGURE 3: Measurements taken for slab studies.

The cubic foot volume was then calculated for each piece as follows:

Example: 4 in. wide, 1 in. thick and 8 ft. long.

Volume = $\frac{4.0 \times 1 \times 8}{144}$ = 0.222 cu. ft.

TABLE 3

SUMMARY OF STUDIES OF SOLID WOOD ON UNEDGED SLABS (1969)

Study No. 1	Cords	Cubic Feet	Cu. ft./cd.
1	0.766	50.85	66.38
2	0.608	33.91	55.76
3	0.747	41.35	55.35
4	0.620	40.97	66.07
5	0.879	63.51	72.25
Totals	3.620	230.59	63.70

From the above studies the following can be determined:

1 cord of unedged slabs = 64 cu. ft. solid wood

thus:

The solid wood equivalent using 0.02832 m^3/cu. ft. OR 35.315 cu. ft./m^3 can be calculated as follows:

1 cord of unedged slabs = 64 X 0.02832

= 1.812 m^3 solid wood

1 m^3 (stacked) unedged slabs = $\frac{35.315}{128}$ = 0.276 cords

= 0.276 X 1.812

= 0.500 m^3 solid wood

Employing a recovery factor of 6.6 fbm/cu. ft. OR 233 fbm/m^3. The fbm volume can be calculated as follows:

1 m^3 (stacked) unedged slabs = 0.500 X 233 = 116 fbm

TABLE 4

SUMMARY OF STUDIES OF SOLID WOOD IN EDGED SLABS (1969)

Study No. 2	Type	Cords	Cubic Feet	Cu.ft./cd.
1	Hand Piled (4, 6, 8" widths)	1.660	123.086	74.15
2	Hand Piled (6" widths)	0.166	14.357	86.48
3	Hand Piled (4" widths)	0.420	28.027	66.73
4	Hand Piled (4" widths)	0.918	46.786	50.96
	Totals	3.164	212.256	67.08

From the above studies the following can be determined:

1 cord of edged slabs = 67 cu. ft. solid wood

The solid wood equivalents can be calculated using 35.315 cu. ft./m^3 OR 0.02832 m^3/cu. ft.

1 cord of edged slabs = 67 X 0.02832

= 1.894 m^3 solid wood

1 m^3 stacked = $\frac{35.315}{128}$ = 0.276 cords

= 0.276 X 1.897

= 0.524 m^3 solid wood

Employing a recovery factor of 6.6 fbm/cu. ft. OR

233 fbm/m^3. The fbm volume can be calculated as follows:

1 m^3 stacked edged slabs = 0.524 X 233
= 122 fbm

The above studies are confirmed by referring to Some Conversion Factors and Related Information (Flan 1962) which states that piled spruce and balsam fir had an average volume of 61 cu. ft. per cord and white pine had a comparable figure of 53 cubic feet.

1.1.3 m^3 (Lumber)

In metric measurements the lumber volume will be based on actual size. This is different from what is now done, as the volume is based on nominal size. The following example shows the nominal, actual and metric on a 2 in. X 6 in. X 16 ft. piece of lumber which is considered to be the average size in Alberta.

Example: 2 in. X 6 in. X 16 ft.

Nominal: $\frac{2 \times 6 \times 16}{12}$ = 16 fbm (nominal)

Actual: 1 1/2 in. X 5 1/2 in. X 16 ft.
(actual dry surfaced size)

Metric: 38.10 mm X 139.70 mm X 4.88 m = 0.02597 m^3
solid wood

The following table shows the actual imperial and metric sizes for various nominal dimensions of lumber.

TABLE 5

LUMBER SIZES FOR IMPERIAL MEASURE AND METRIC MEASURE

Imperial Units (inches)			Metric Units (mm)		
Nominal	Actual Surfaced Dry	Green	Nominal	Actual Surfaced Dry	Green
Thickness					
1	3/4	25/32	19	19.05	19.84
1 1/4	1	1- 1/32	25	25.40	26.19
1 1/2	1 1/4	1- 9/32	32	31.75	32.54
2	1 1/2	1- 9/16	38	38.10	39.69
3	2 1/2	2- 9/16	64	63.50	65.09
4	3 1/2	3- 9/16	89	88.90	90.49
Width					
2	1 1/2	1- 9/16	38	38.10	36.69
3	2 1/2	2- 9/16	64	63.50	65.09
4	3 1/2	3- 9/16	89	88.90	90.49
5	4 1/2	4- 5/8	114	114.30	114.47
6	5 1/2	5- 5/8	140	139.70	142.87
7	5 1/2	6- 5/8	165	165.10	168.28
8	7 1/4	7- 1/2	184	184.15	190.50
10	9 1/4	9- 1/4	235	234.95	241.30
12	11 1/4	11- 1/2	286	285.75	292.10

Source: Metric Manual for Wood Products.
Canadian Wood Council.

The relationship between the nominal size and the actual finalized size varies with the different sizes of lumber. The following table expresses the relationship with the actual size shown as a per cent of the nominal volume.

TABLE 6

COMPARISON OF NOMINAL AND ACTUAL SIZES

Actual Size Volume as a Percentage of Nominal Volume			
Nominal Size	Actual as % of Nominal	Nominal Size	Actual as % of Nominal
2 X 2	56.25		
2 X 3	62.50	1 X 3	62.50
2 X 4	65.63	1 X 4	65.75
2 X 6	68.75	1 X 6	68.83
2 X 8	68.00	1 X 8	68.00
2 X 10	69.40	1 X 10	69.40
2 X 12	70.33	1 X 12	70.33

Source: Calculated from Table 5 measurements.

The relationship between 1 000 fbm and m^3 (lumber) is thus calculated as follows:

No. of pieces of 2 X 6 X 16 per 1 000 fbm = 1 000/16 - 62.5 pieces

62.5 X 0.02597 = 1.623 m^3 solid wood

The factor is the same as is given in the Metric Handbook for Canadian Softwood Lumber. It will be used when the lumber market changes to metric and should not be confused with the m^3 (roundwood) factors which are used for timber dues volumes.

1.2 Mass

In metric the terms kilograms and tonnes are employed in weighing wood. These are related to the imperial measure as follows:

1 kilogram = 2.205 pounds
or 1 pound = 0.454 kilogram
1 tonne = 2 204.62 pounds or 1.102 tons
or 1 ton = 907.2 kilograms or 0.907 tonnes
1 tonne = 1 000 kilograms

2. RECOVERY FACTORS

In the imperial measurement system, various log rules were developed to estimate the amount of lumber that could be recovered from a log. The actual mill outrun was often compared to this estimate and the amount of overrun or underrun was calculated.

The volume measurement in metric is, however, in terms of sound round log volumes. To obtain an estimate of lumber, an average fbm/m^3 lumber recovery factor (LRF) was established.

Recovery factors may be expressed in different ways to suit the particular product being measured, such as Bone Dry Units (BDU) for chips or square feet of 3/8 inch plywood. As well, it is sometimes desirable to calculate the recovery of various products as a per cent of the roundwood scaled into the mill. This approach is used with sawmill residue where the percentage of lumber, shavings and sawdust is calculated and the remainder considered chipable wood.

2.1 Lumber

The conversion factor of 233 fbm/m^3 (roundwood) was established by three separate types of calculations.

Firstly, the projected total volumes of all merchantable spruce and pine logs in the province was calculated and the average size and recovery was calculated as shown in Table 7. The calculations were based upon the gross volumes by the Alberta Cubic Foot Scale and the Alberta

Log Scale for all logs five inches and over in diameter and six feet and over in length. (Appendix 2 shows the average sizes for subsequent years).

TABLE 7

CALCULATION OF AVERAGE LOG SIZE

Logs from weight scaling 1977/78

Number of Logs		
(five inch diameter and larger, six feet and longer)	15 594 729	
Length of Logs		
Lineal feet (5" + and 6' +)	185 462 948	
Average length/log		11.89267 feet 3.624886 metre
Cubic Feet (Smalian with taper (10X)		
Cubic feet (5" + and 6' +)	839 429 795	
Average cu. ft./log		53.82779 cuft(10X)
Average cu. ft./lineal ft.		4.52613 cuft(10X)
Average mid-point diameter $\frac{0.452613}{0.00545415}$		9.109614 inches (23.13842 cm)
Average top diameter cm = 21.39156 (22 cm)		
Alberta Log Scale		
Board feet (5" + and 6' +)	552 940 534	
Average fbm/log		35.456886 fbm/log
Average LRF = $\frac{552\ 940\ 534}{83\ 942\ 979.5}$ = 6.587 fbm/cu.ft.		
Average fbm/m^3 = 6.587 X 35.315 = = 232.62 (233) fbm/m^3		

Secondly, the average log size of 22 cm and 3.6 metres can be compared by using the scaling tables.

Alberta Log Scale 22/3.6 = 37

Alberta m^3 Scale 22/3.6 = .159

Average LRF = $\frac{37}{1.59}$ = 232.70 (233 fbm/m^3)

The variance of the LRF by log size may be calculated by choosing various sizes on the log scale tables and comparing these. An example of the variance is shown in Table 8.

TABLE 8

FBM/m^3 RATIOS BY LOG SIZE

TOP DIAMETER (cm)	2.4 m LOG			4.8 m LOG		
	m^3	fbm	fbm/m^3	m^3	fbm	fbm/m^3
10	0.023	2	87	0.054	7	130
14	0.042	7	167	0.097	18	186
18	0.068	14	206	0.153	33	216
22	0.101	23	228	0.223	53	238
26	0.140	34	243	0.308	77	250
30	0.186	48	258	0.409	106	259
34	0.239	64	268	0.526	139	264
38	0.300	82	273	0.660	176	267
42	0.367	102	278	0.811	218	269
46	0.442	125	283	0.981	265	270

Thirdly, the lumber recovery factor was compared by summarizing studies from several efficient sawmills as shown in Table 9. The data and compilations were done in imperial measure with the end result converted to m^3.

TABLE 9

BOARD FOOT - CUBIC FOOT CONVERSION FACTORS

	Net Lumber	Cubic Firmwood		Alberta Log Rule	
Mill No.	Fbm Nominal	Cu. ft.	LRF	Net Fbm	LRF
1	66 843	9 180.0	7.28	59 278	6.46
2	25 739	3 558.6	7.23	23 388	6.57
3	39 640	6 640.9	5.97	43 858	6.60
4	25 026	3 998.1	6.26	26 974	6.75
5	38 055	6 186.9	6.15	38 269	6.19
6	89 652	12 956.6	6.92	89 460	6.90
	284 955	42 521.1		281 227	

Average LRF $\frac{284\ 955}{42\ 521.1}$ = 6.70 fbm/cu. ft. $\frac{281\ 277}{41\ 521.1}$ = 6.61 fbm/cu. ft.

Average fbm/m^3 from mill outrun = 6.70 X 35.315 = 236.6 fbm/m^3

Average fbm/m^3 from log rule = 6.61 X 35.315 = 233.4 fbm/m^3

2.2 Lumber (Per Cent of Scaled Volume)

Using the same mill study data as in Table 9, the percentage of lumber recovered from the total solid wood volume of the logs was calculated. The results are shown in Table 10. Data from subsequent studies is shown in Table 20.

TABLE 10

LUMBER RECOVERY AS A PERCENTAGE

Mill No.	Actual Cu. ft. Lumber (10X)	Cu. ft. of Logs (10X)	Per cent Recovery
1	3 638.4	9 180.0	39.63
2	1 443.9	3 558.6	40.57
3	2 250.9	6 640.9	33.89
4	1 413.9	3 998.1	35.36
5	2 151.6	6 186.9	34.78
6	5 048.1	12 956.6	38.96
	15 946.8	42 521.1	37.50

2.3 Railway Ties

Figure 4 illustrates the specifications of the Canadian National Railways purchasing department (as confirmed to August 12, 1981) for the grades of railway ties.

Tie volume calculations are based on these specifications.

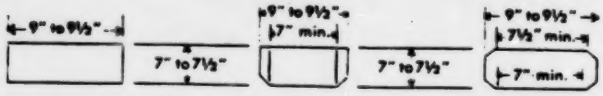
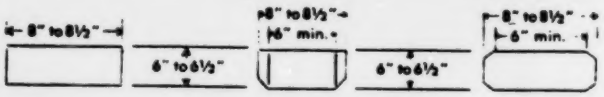
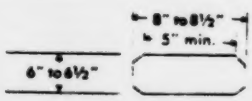
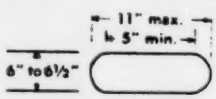
GRADE	SAWED TOP BOTTOM & SIDES	SAWED TOP & BOTTOM ONLY
1		
2		
3		
3A		

FIGURE 4: Specifications for railway ties by Canadian National Railways

2.3.1 Grade No. 1

The volumes were calculated using the maximum dimensions and the minimum dimensions. These volumes were then averaged as follows:

Maximum dimensions 9 1/2 in. X 7 1/2 in. X 8 ft.

$$\text{Maximum volume} = \frac{9.5 \times 7.5 \times 8}{12} = 47.50 \text{ fbm}$$

An adjustment $\frac{32}{37}$ for finishing was made using the principle outlined for the Alberta Log Rule.

$$\text{Thus, adjusted fbm} = 47.50 \times \frac{32}{37} = 41.08 \text{ fbm}$$

Minimum Dimensions 9 in. X 7 in. X 8 ft.

Minimum Volume $\frac{9 \text{ X } 7 \text{ X } 8}{12} = 42.00$ fbm

Adjusted fbm = $42.00 \text{ X } \frac{32}{37} = 36.32$

Grade #1 Tie Average Volumes

The average fbm volume = $\frac{41.08 + 36.32}{2} = 38.7\ (39)$ fbm

Solid Wood Content

Maximum = 47.50/12 = 3.96 cu. ft.

Minimum = 42.00/12 = 3.50 cu. ft.

Average (cu. ft.) $\frac{3.96 + 3.50}{2} = 3.73$ cu. ft.

m^3 solid wood = 3.73 X 0.02832 = 0.106 m^3

Roundwood Equivalent

m^3 (roundwood) = $\frac{39}{233} = 0.166\ m^3$

2.3.2 Grade No. 2 and No. 3 Ties

Maximum dimensions 8 1/2 in. X 6 1/2 in. X 8 ft.

Maximum Volume = $\frac{8.5 \text{ X } 6.5 \text{ X } 8}{12} = 36.83$ fbm

Adjusted fbm = $36.83 \text{ X } \frac{32}{37} = 31.85$ fbm

Minimum dimensions 8 in. X 6 in. X 8 ft.

Minimum volume $\frac{8 \text{ in. X } 6 \text{ in. X } 8 \text{ ft.}}{12} = 32$ fbm

Adjusted fbm = $32 \text{ X } \frac{32}{37} = 27.68$ fbm

Grade #2 Tie Average Volumes

The average fbm = $\frac{31.85 + 27.68}{2}$ = 29.77 (30) fbm

Solid Wood Content

Maximum = $\frac{36.83}{12}$ = 3.07

Minimum = $\frac{32}{12}$ = 2.67

Average (cu. ft.) = $\frac{3.07 + 2.67}{2}$ = 2.87

m^3 solid wood = 2.87 X 0.02832 = 0.081 m^3

Roundwood Equivalent

m^3 roundwood = $\frac{30}{233}$ = 0.129 m^3

2.4 Lath

A piece of lath has dimensions of 3/8 in. X 1 1/2 in. X 4 ft.

Thus the volume of a piece = $\frac{0.375 \times 1.5 \times 4}{12}$ = 0.1875 fbm

Bundles

Lath is sold in bundles of 50.

Fbm (1 Bundle) = 50 X 0.1875 = 9.375 fbm

Cu. ft. of solid wood = $\frac{9.375}{12}$ = 0.781

m^3 of solid wood = 0.781 X 0.02832 = 0.024 m^3

1 000 Pieces Lath

Fbm (1 000 pcs.) = 1 000 X 0.1875 = 187.5 fbm (188)

Cu. ft. of solid wood = $\frac{0.781}{50}$ X 1 000 = 15.62

m^3 of solid wood = $\frac{0.0221}{50}$ X 1 000 = 0.442 m^3

Roundwood equivalent = $\frac{188}{233}$ = 0.807 m^3

2.5 Sawmill Residue

The amount of sawmill residue can vary among mills as it depends upon the manufacturing practices and the equipment used. Table 11 shows the estimated yields from various types of mills studied in British Columbia.

TABLE 11

ESTIMATED RESIDUE YIELDS BY SAWMILL TYPE
IN BRITISH COLUMBIA

Mill Type	CUBIC FEET OF RESIDUES - SOLID WOOD EQUIVALENT					
	Per 100 Cu. Ft. logs			Per M fbm lumber		
	Sawdust	Pulp chips	Planer shavings	Sawdust	Pulp chips	Planer shaving
Band headrig	12	31	11	16	41	15
Circular headrig	15	30	11	21	43	16
Scrag mill	20	31	11	33	52	18
Chipper headrig	6	43	10	9	66	15
Log gang	11	35	10	16	50	14

Source: Conversion Factors for the Forest Products Industry in Western Canada & D. M. Wright (Environment Canada Report UP-X-97).

The amount of residue can also be predicted using the principles outlined in the Guide to Sawmill Studies and the sawdust calculation procedure outlined in Appendix 1.

Percentages are used to reflect the distribution of material from a m^3 of sound roundwood put through the mill. In order to calculate the amount of wood available for chipping, the amount used in making up lumber, shavings and sawdust are calculated first. These volumes are then subtracted from the net m^3 scale to arrive at the amount of wood available for chipping. An example of a calculation using sawmill data is as follows:

Total m^3 roundwood (net scale) (see report)	10.002 m^3	(100.00%)
Planed lumber (see figure 5)	3.905 m^3	(39.04%)
Shavings & shrinkage (see figure 5)	1.829 m^3	(18.29%)
Sawdust (see appendix 1)	1.500 m^3	(15.00%)
Amount remaining for woodchips	2.768 m^3	(27.67%)

To obtain sufficient data to verify the above calculations several sawmill studies will be required. Results of the studies will be periodically summarized in Table 20.

Alberta
ENERGY AND NATURAL RESOURCES

SAWMILL STUDY REPORT

MILL: Ajax Sawmills	STUDY NO: 1	DATE: 80/12/06
MILL LOCATION:	RANGER DISTRICT	FILE NO.

1. SCALE DATA (m^3)

Gross Scale (1000X)	10 708		
Deductions (1000X)	706	Deduction%	6.6
Net Scale (1000X)	10 002	No. of Merch. Logs	49
Net Scale (1X)	10 002	Merchantable Length	201.6
		Gross m^3/m (1000X) (whole number)	53

2. LUMBER DATA (fbm)

Lumber from Sawmill	2 584	fbm% 1"	7.0 % 2" + 93.0
Planer Factor	0.954	% Falldown	4.6
Net Lumber Saleable	2 465		
Lumber Recovery (fbm/m^3) (0 dec.)		Mill Recovery 246	Average Recovery 222

3. LUMBER DATA (m^3 Planed)

Lumber from Sawmill (1000X)	4 093	Headsaw Kerf	5/16"
Planer Factor (1000X)	0.954	Gang Saw Kerf	3/16"
Net Lumber Saleable (1000X)	3 905	Resaw Kerf	(chipper)
% Recovered as Lumber (2 dec.)		Mill Recovery 39.04	Average Recovery 34.38

4. LUMBER DATA (m^3 Rough)

Rough Lumber Gross Volume (1000X)	5 922	NOTE: This calculation is optional and only required if shaving loss is desired.	
Planed Lumber Gross Volume (1000X)	4 093		
Loss to Shrinkage & Shavings	1 829	Net Scale m^3 (1000X)	10,002
		%Loss (2 dec.)	18.29

SIGNATURE

FIGURE 5: Sawmill study report

2.5.1 Woodchip Recovery

The amount of woodchips available from milling is dependent upon:

(1) The size of logs.

(2) The type of sawmill equipment.

(3) The option of producing low grade lumber vs. woodchips.

Depending upon the various combinations of the above factors, there can be a large variation in the amount of woodchips recovered.

In Appendix 2, two methods were studied to analyse influences on the woodchip recovery and to calculate an average recovery factor. The results were compared to the estimated residual yields by sawmill type in British Columbia (Table 11).

A summary of the two methods is as follows:

(1) A theoretical calculation of woodchip recovery based on the principles of the Alberta Log Rule. (Appendix 2 (a)). This method estimated an average of 0.392 BDU per Mfbm or 0.090 BDU per m^3.

Although this method indicates the probable influence of size on recovery, the estimate is somewhat lower than usually expected.

(2) A weighted average recovery based upon sawmill study data (Appendix 2 (b)) between Nov. 1/79 and June 1/84. This method indicated an average recovery of 0.528 BDU/Mfbm or 0.123 BDU/m^3.

The average relates well to the British Columbia estimates shown in Table 11.

There is a trend toward utilization of smaller wood. Recognizing this trend, the following factors are considered as a probable standard.

Average Woodchip Recovery
BDU/Mfbm = 0.600
BDU/m^3 = 0.140

Bell's A Pulpwood Chip Program to Utilize Sawmill Residue also indicates that approximately four per cent could be lost in chip production for fines, trim ends, etc. when considering chip recovery from a sawmill operation.

2.6 Pulp Recovery

The yield of pulp from a unit of wood input varies with species, mill and type of pulp produced. Table 12 shows yields normally expected.

TABLE 12

GREEN WOOD REQUIREMENTS PER TONNE OF AIR DRY KRAFT PULP

SPECIES	UNBLEACHED KRAFT			BLEACHED KRAFT		
	cu. ft.	m^3 (roundwood)	m^3 (stacked)	cu. ft.	m^3 (roundwood)	m^3 (stacked)
Spruce-ton	179	5.069	7.634	190	5.381	8.104
-tonne		5.586	8.413		5.930	8.931
Pine-ton	160	4.531	6.824	170	4.814	7.250
-tonne		4.993	7.520		5.305	8.000
Poplar-ton	142	4.021	6.056	151	4.276	6.440
tonne		4.431	6.674		4.712	7.097

The above cu. ft. data was obtained from Dobie and Wright's Conversion Factors for the Forest Product Industry. To obtain the metric yield from imperial measures in the original source the following calculations were made:

m^3 ton = cu. ft. X 0.02832 Where: 0.02832 = m^3/cu. ft.

m^3 (stacked)/ton = m^3/ton X 1.506 1.506 = $\frac{128 \text{ cu. ft.}}{85 \text{ cu. ft.}}$ ratio

m^3/tonne = m^3/ton X 1.102 1.102 = Tons/tonne

2.7 Plywood Yield

The yield of plywood logs is usually based on the square feet of 3/8" plywood per cubic feet of roundwood used. Table 13 indicates the amount of plywood that could be obtained from various diameters.

TABLE 13

PLYWOOD RECOVERY

Based on 2.4 metre length and 12 cm (5 in.) core

Top Diameter	Alta. m^3 Scale (m^3 1 000X)	Basal area of Top (m^3)	Volume of cylinder (m^3 1 000X)	Gross Veneer (cyl.-core) %	Net Plywood (Less 16.3% waste) %	Sq. ft. 3/8" Plywood per Bolt	Sq. ft. 3/8" Plywood per m^3 (Rw)*
20	84	0.031	74.4	57.14	40.84	39	461
22	101	0.038	91.2	64.16	47.86	55	541
24	120	0.045	108.0	68.00	51.70	70	584
26	140	0.053	127.2	72.00	55.70	88	629
28	162	0.062	148.8	75.56	59.26	108	670
30	186	0.071	170.4	77.42	61.12	128	691
32	212	0.080	192.0	78.11	61.81	148	698
34	239	0.091	218.4	80.33	64.03	173	724
36	269	0.102	244.8	81.19	64.89	197	733
38	300	0.113	271.2	81.60	65.30	221	738
40	333	0.126	302.4	82.88	66.58	251	752
42	367	0.139	333.6	83.71	67.41	280	762
44	404	0.152	364.8	83.76	67.46	308	762
46	442	0.166	398.4	84.16	67.86	339	767
48	483	0.181	434.4	84.47	68.17	372	770
50	525	0.196	470.4	84.57	68.27	405	771
52	570	0.212	508.8	84.63	68.33	440	772
54	616	0.229	549.6	84.94	68.64	478	776
56	664	0.246	590.4	84.94	68.64	515	776
58	715	0.264	633.6	84.92	68.62	554	775
60	767	0.283	679.2	85.11	68.81	596	778

*m^3 (Roundwood scale)

The calculations for the per cent recovered as plywood are as follows:

(a) Volume of the core (1 000X)

= Basal area (12 cm) X length (2.4) X 1 000

= .011 X 2.4 X 1 000 = 26.4 m^3 (1 000X)

(b) Volume of the cylinder = Basal area X length X 1 000

i.e. 20 cm = .031 X 2.4 X 1 000 = 74.4 m^3 (1 000X)

(c) Gross % veneer = $\frac{\text{volume cylinder - volume of core}}{\text{Alberta } m^3 \text{ scale}}$ X 100

i.e. $\frac{74.4 - 26.4}{84}$ X 100 = 57.14

Net % plywood = Gross % - 16.3% loss for trim & drying

Losses between the veneer drier and the plywood panel are estimated to average 16.3%. This percentage was indicated in Dobie and Wright's Conversion Factors for the Forest Products Industry based on research by Hunt and Woodfin, 1970.

The calculations to obtain the thousand sq. ft. 3/8 in. plywood per m^3 roundwood are as follows:

(a) Cubic feet per 1 000 sq. ft. of 3/8" plywood

= $\frac{0.375" \text{ X } 12" \text{ X } 12" \text{ X } 1\,000}{12" \text{ X } 12" \text{ X } 12"}$ = 31.250 cu. ft.

(b) 1 000 sq. ft. of 3/8" plywood per m^3 = $\frac{35.315}{31.250}$ = 1.130 M sq. ft.

(c) $\frac{\text{1 000 sq. ft. per bolt}}{\text{M sq. ft.}}$ = (Alta. m^3 scale X net % X 1.130)

i.e. 20 cm = (84 X .4084 X 1.130) = 0.038 M sq. ft./bolt

(c) $\frac{\text{1 000 sq. ft. per } m^3}{\text{M sq. ft.}}$ = $\frac{\text{1 000}}{\text{Alta. } m^3 \text{ scale}}$ = X vol./bolt

i.e. 20 cm - $\frac{1\,000}{84}$ = 0.452 M sq. ft./m^3

3. MASS - VOLUME RELATIONSHIPS

Through the years researchers have done various studies on the weights and moisture content of wood on the major tree species. Few studies have, however, been done specifically for Alberta. The data being quoted is thus obtained from sources in Eastern Canada and British Columbia.

The measurements usually define the basic density which is the ratio of the species density to the density of water at 4°C. The specific gravity X 62.4 (lbs. of water per cubic foot) equals the weight of wood per cubic foot.

Moisture Content (MC) of wood may be expressed as a per cent of the oven dry weight or of the original green wood weight. The values shown in Table 14 and Table 15 are as a per cent of the oven dry weight.

Using the specific gravity and moisture content, the green weight can be calculated as follows:

Green Weight (Pine, Jack) = 62.4 X .42 X 1.90 = 49.8

A further estimate of total green weight can be determined by adding on bark weights. Flan's Conversion Factors for Eastern Canada indicates that bark is about eight per cent for Jackpine, 10% for other softwoods and 12% for hardwoods. As well approximately 10% for trim allowance should also be considered for saw timber.

Data from two main sources of wood density and moisture content are shown in Table 14 and Table 15. The data has been converted to metric for comparison with the Alberta Weight-Volume relationships.

TABLE 14

SUMMARY OF WEIGHTS AND MOISTURE CONTENT
FROM EASTERN CANADA

Species	Basic Specific Gravity	Basic Weight Per cu. ft. Green (oven dry lbs)	Ave. Moisture Content (% OD)	Approx. Green Weight (lbs./cu.ft.)	Metric Green Weight (kg/m^3)
Pine, Jack	0.42	26.2	90	49.8	798
Spruce, White	0.35	21.8	115	47.0	755
Birch, White	0.56	35.0	73	59.2	949
Aspen, Trembling	0.39	24.4	104	49.8	798

Source: Some Conversion Factors for Eastern Canada by I. B. Flan

TABLE 15

SUMMARY OF WEIGHTS AND MOISTURE CONTENT
FROM WESTERN CANADA

Species	Basic Specific Gravity	Basic Weight Per cu. ft. Green (over dry lbs.)	Ave. Moisture Content (% OD)	Approx. Green Weight (lbs./cu.ft.)	Metric Green Weight (kg/m^3)
Pine, Lodgepole	0.41	25.50	50.0	38.2	612
Spruce, White	0.36	22.45	59.0	35.7	572
Fir, Balsam	0.34	21.22	118.0	46.3	742
Aspen Trembling	0.37	23.09	90.0	43.9	704

Source: Conversion Factors for the Forest Products Industry in Western Canada by J. Dobie and D. M. Wright

3.1 Roundwood

Table 16 shows a summary of weight scale from 1979/80 to 1982/83. The average data has been calculated as follows:

TABLE 16

SUMMARY OF WEIGHT SCALES ON CONIFEROUS WOOD

Timber Year	Loads	Weight	Volume	Ratio
1979/80	61 960	2 369 742 300	2 713 535	873.
1980/81	65 625	2 491 820 096	2 902 479	858.
1981/82	65 480	2 480 386 247	2 982 513	832.
1982/83	68 715	2 765 033 521	3 314 005	834.
	261 780	10 106 982 164	11 912 532	848.

Average Ratio $\frac{10\ 106\ 982\ 164}{11\ 912\ 532} = 848.432\ km/m^3$

Average Wt./Load $\frac{10\ 106\ 982\ 164}{261\ 780} = 38\ 609\ km$

Average Vol./Load $\frac{11\ 912\ 532}{261\ 780} = 45.505\ m^3$

The average weight for 100 loads of aspen wafer logs scaled during 1982 was 1 043 kg/m^3. This, of course, will be subject to change once more sampling is done.

3.2 Lumber

Lumber data was collected in 1973 from various lumber companies. The data was either from loads into the mill yard (rough) or from shipments out of the mill yard (surfaced).

The original data was summarized in fbm and lbs. (Table 17). The summaries later converted to metric equivalents as per Table 18 and Table 19.

TABLE 17

LUMBER WEIGHTS (lbs./Mfbm)

	SIZE	NO. OF SAMPLES	WEIGHT (lbs.)	VOLUME (fbm)	RATIO lbs./Mfbm	ROUNDED CONVERSION
Rough Green Coniferous	2"	199	12 980 096	4 961 097	2 616	2 600
	1"	9	462 590	111 747	4 140	4 150
Surfaced Green Coniferous	2"	21	1 796 280	871 755	2 061	2 050
Surfaced Dry Coniferous	2"	125	3 996 905	5 497 542	1 637	1 650
	1"	8	587 750	344 571	1 706	1 700
Surfaced Dry Deciduous					1 500	1 500

TABLE 18

LUMBER WEIGHTS (kg/Mfbm)

	Size	Lbs./Mfbm	Kg/Mfbm @ 0.454	Rounded Factor
Rough Green Coniferous	2"	2 616	1 188	1 190
	1"	4 140	1 880	1 880
Surfaced Green Coniferous	2"	2 061	936	935
Surfaced Dry Coniferous	2"	1 637	743	745
	1"	1 706	775	755
Surfaced Dry Deciduous	2"	1 500	681	680

TABLE 19

LUMBER WEIGHTS (kg/m^3[Lumber])

	Size	Kg/Mfbm	m^3 Lumber* per Mfbm	Kg/Per m^3 Lumber	Rounded Factor
Rough Green Coniferous	2"	1 188	2 364	503	505
	1"	1 880	2 318	811	810
Surfaced Green Coniferous	2"	936	1 623	577	575
Surfaced Dry Coniferous	2"	743	1 623	458	460
	1"	775	1 623	478	480
Surfaced Dry Deciduous	2"	681	1 623	420	420

*Source: Metric Manual of Wood Products
1 264 Based on 2 X 6 rough
2 318 Based on 1 X 6 rough
1 623 Based on 2 X 6 surfaced or 1 X 6 surfaced.

3.3 Woodchips

In Alberta woodchips are sold by the Bone Dry Unit (BDU). This unit refers to 2 400 pounds of chips which has been ovendried.

To calculate the volume of solid wood in a BDU the weights outlined in the Flan's Conversion Factors for Forest Products in Eastern Canada was used. These factors of course were confirmed by the studies done for Smith's Wood Density Survey in Western Canada.

Pine (using 26 lbs./cu.ft. = $\frac{2\ 400}{26}$ = 92 cu. ft. of chip wood)

Spruce (using 22 lbs./cu. ft. = $\frac{2\ 400}{22}$ = 109 cu. ft. of chip wood)

Assuming on mixture of wood, then the average $(\frac{92 + 109}{2})$ is 100 cubic feet of roundwood equivalent per BDU. This is equivalent to 100/3.315 = 2.832 m3 (roundwood).

This can be, of course, converted to the metric weight in the following manner.

1 Tonne = 2 204.62 pounds

= $\frac{2400}{2\ 204.62}$ = 1.089 BDU

= 1.089 X 2.832 = 3.084 m^3 (roundwood)

TABLE 20

BREAKDOWN OF PRODUCTS AND BYPRODUCTS
CALCULATED AS PERCENTAGES

YEAR	STUDY	NET SCALE	M3/M (1000 X)	M3 LUMBER	% LUMBER	M3 SAWDUST	% SAWDUST	M3 SHAVING	% SHAVING	M3 WOODCHIP	% WOODCHIP	PLANED MFBM	BDU/ MFBM	FBM/M3 SCALE
1980	1	88.743	37.2	30.297	34.14	13.365	15.06	16.311	18.38	28.770	32.42	19.183	0.530	216
1981	2	82.050	39.2	23.540	28.69	9.944	12.12	11.651	14.20	36.914	44.99	14.934	0.873	182
1981	3	86.585	64.0	27.898	32.22	14.174	16.37	12.520	14.46	31.993	36.94	17.413	0.649	201
1981	4	72.743	41.2	22.056	30.32	13.276	18.25	9.988	13.73	27.424	37.69	13.936	0.695	192
1981	5	50.238	40.7	17.352	34.54	10.535	20.97	7.611	15.15	14.740	29.34	11.058	0.471	220
1981	6	45.875	41.5	13.845	30.18	8.069	17.59	5.748	12.53	18.212	39.70	8.757	0.734	191
1981	7	30.695	33.6	10.218	33.29	6.560	21.37	3.831	12.48	10.086	32.86	6.604	0.539	215
1981	8	19.231	43.8	7.037	36.59	5.925	30.81	3.567	18.55	2.702	14.05	4.603	0.207	239
1981	9	87.956	39.9	26.677	30.33	16.791	19.09	12.182	13.85	32.306	36.73	16.916	0.674	192
1982	10	75.923	45.9	27.833	36.66	16.035	21.12	12.679	16.70	19.376	25.52	17.545	0.390	231
1982	11	72.302	54.5	24.539	33.94	13.434	18.58	10.665	14.75	23.664	32.72	15.378	0.543	213
1982	12	21.900	47.5	8.007	36.56	5.727	26.15	4.238	19.35	3.929	17.94	5.240	0.265	239
1982	13	59.606	60.6	23.038	38.65	11.957	20.06	10.783	18.09	13.829	23.20	14.588	0.335	245
1982	14	24.807	30.0	8.355	33.68	5.180	20.88	4.455	17.96	6.817	27.48	5.363	0.449	216
1982	15	27.956	36.7	10.352	37.03	6.153	22.01	5.429	19.42	6.022	21.53	6.608	0.322	236
1982	16	26.013	41.2	10.088	38.78	6.873	26.42	3.754	14.43	5.299	20.37	6.548	0.286	252
1982	17	39.678	35.3	11.550	29.11	7.614	19.19	5.618	14.16	14.895	37.55	7.367	0.714	186
1982	18	54.232	44.2	17.880	32.97	9.219	17.00	6.855	12.64	20.277	37.39	11.713	0.611	216
1982	19	66.486	49.5	22.426	33.73	13.357	20.09	11.755	17.68	18.949	28.50	14.097	0.475	212
1982	20	45.530	44.4	15.216	33.42	7.881	17.31	5.905	12.97	16.527	36.31	9.996	0.584	220
1982	21	34.900	43.4	11.269	32.29	7.057	20.22	6.128	17.56	10.446	29.93	7.590	0.486	217
1983	22	52.876	39.1	16.894	31.95	10.554	19.96	7.091	13.41	18.337	34.68	10.671	0.607	202
1983	23	51.128	73.8	17.864	34.94	9.408	18.40	8.533	16.69	15.323	29.96	11.134	0.486	218
1983	24	122.388	46.8	64.804	52.95	26.350	21.53	4.063	3.32	27.170	22.19	30.863	0.311	252
1983	25	52.379	73.5	20.145	38.46	11.817	22.56	9.365	17.88	11.052	21.09	12.762	0.306	244
1983	26	94.427	43.8	41.189	43.62	2.767	2.93	14.277	15.12	36.194	38.33	25.635	0.499	271
1983	27	47.276	39.1	16.239	34.35	8.146	17.23	6.614	13.99	16.277	34.43	10.660	0.539	225
1983	28	45.926	52.6	15.482	33.71	10.154	22.11	5.888	12.82	14.402	31.36	9.764	0.521	213
1983	29	256.406	33.4	118.870	46.36	22.205	8.66	37.922	14.79	77.409	30.18	69.453	0.394	271
1983	30	41.191	51.1	13.568	32.94	8.984	21.81	5.155	12.54	13.474	32.72	8.535	0.557	207

TABLE 20 (CONT'D)

BREAKDOWN OF PRODUCTS AND BYPRODUCTS
CALCULATED AS PERCENTAGES

YEAR	STUDY	NET SCALE	M3/M (1000 X)	M3 LUMBER	% LUMBER	M3 SAWDUST	% SAWDUST	M3 SHAVING	% SHAVING	M3 WOODCHIP	% WOODCHIP	PLANED MFBM	BDU/ MFBM	FBM/M3 SCALE
1983	31	17.896	55.5	7.085	39.59	3.488	19.49	3.595	20.09	3.728	20.83	4.486	0.293	251
1983	32	51.092	54.8	18.071	35.37	11.194	21.91	6.320	12.37	15.506	30.35	11.339	0.483	222
1983	33	30.963	48.6	11.741	37.92	6.090	19.67	5.957	19.24	7.174	23.17	7.482	0.339	242
1983	34	13.541	33.8	5.129	37.88	3.946	29.14	2.529	18.68	1.936	14.30	3.288	0.208	243
1983	35	15.442	37.8	5.859	37.94	4.125	26.71	1.881	12.18	3.578	23.17	3.765	0.336	244
1983	36	51.232	43.3	17.368	33.90	8.868	17.31	7.039	13.74	17.957	35.05	11.391	0.557	222
1983	37	75.187	46.1	28.992	38.56	16.293	21.67	12.586	16.74	17.316	23.04	18.267	0.335	243
1984	38	74.662	46.8	28.423	38.07	15.654	20.97	12.821	17.17	17.764	23.79	17.816	0.352	239
1984	39	37.884	37.5	15.048	39.72	7.577	20.00	6.941	18.32	8.318	21.96	9.842	0.298	260
1984	40	60.377	44.9	21.123	34.99	12.304	20.38	8.903	14.75	18.047	29.89	13.397	0.476	222
1984	41	72.857	54.7	23.757	32.61	16.100	22.10	11.236	15.42	21.764	29.87	14.989	0.513	206
1984	42	61.913	64.0	23.970	38.72	12.810	20.69	10.003	16.16	15.130	24.44	15.160	0.352	245
1984	43	69.996	41.0	24.070	34.39	17.359	24.80	11.119	15.89	17.448	24.93	15.237	0.404	218
1984	44	42.280	43.9	15.015	35.51	7.669	18.14	6.904	16.33	12.692	30.02	9.839	0.456	233
1984	45	14.505	42.3	5.395	37.19	3.151	21.72	2.643	18.22	3.316	22.86	3.328	0.352	229
1984	46	22.655	54.9	8.485	37.45	5.035	22.22	4.281	18.90	4.854	21.43	5.156	0.332	228
1984	47	19.671	50.3	7.065	35.92	3.616	18.38	3.600	18.30	5.390	27.40	4.369	0.436	222
1984	48	56.976	42.0	19.573	34.35	11.266	19.77	9.138	16.04	16.999	29.84	12.037	0.499	211
1984	49	29.124	38.4	8.941	30.70	4.691	16.11	3.796	13.03	11.696	40.16	5.847	0.706	201
1984	50	223.178	66.2	94.280	42.24	17.708	7.93	29.344	13.15	58.775	26.34	58.775	0.353	263
1985	51	18.897	56.6	7.620	40.32	4.047	21.42	3.967	20.99	3.263	17.27	4.655	0.248	246
1985	52	57.865	34.1	20.481	35.39	10.531	18.20	9.439	16.31	17.414	30.09	13.386	0.459	231
1985	53	42.951	31.9	12.804	29.81	8.361	19.47	7.278	16.94	14.508	33.78	8.162	0.628	190
1985	54	40.172	45.6	14.944	37.20	7.656	19.06	8.144	20.27	9.428	23.47	9.441	0.353	235
1985	55	47.881	48.7	21.419	44.73	10.500	21.93	8.417	17.58	7.545	15.76	13.994	0.190	292
1985	56	37.631	40.5	13.571	36.06	7.559	20.09	3.789	10.07	12.712	33.78	8.594	0.522	228
1985	57	40.606	32.3	16.911	41.65	8.161	20.10	5.708	14.06	9.826	24.20	11.015	0.315	271
1985	58	140.176	36.2	52.502	37.45	11.338	8.09	16.766	11.96	59.570	42.50	33.039	0.637	236
1985	59	194.069	59.4	77.798	40.09	15.174	7.82	24.437	12.59	76.660	39.50	48.593	0.557	250
1985	60	27.426	41.0	9.864	35.97	5.729	20.89	2.633	9.60	9.200	33.54	6.229	0.522	227
		3566.551		1331.833	37.34	597.509	16.75	521.808	14.63	1092.330	30.63	827.832	0.466	232

APPENDIX 1

CALCULATION OF SAWDUST VOLUMES FROM MILL STUDIES

With the additional information on Saw Kerf size being included in Guidelines for Sawmill Studies, an estimate of sawdust can also be calculated on detailed mill studies when rough lumber measurements have been taken.

The principle behind the calculations is that the log will be broken down in two or more steps. Firstly, by use of a scrag saw or chipper, the end result being a cant:

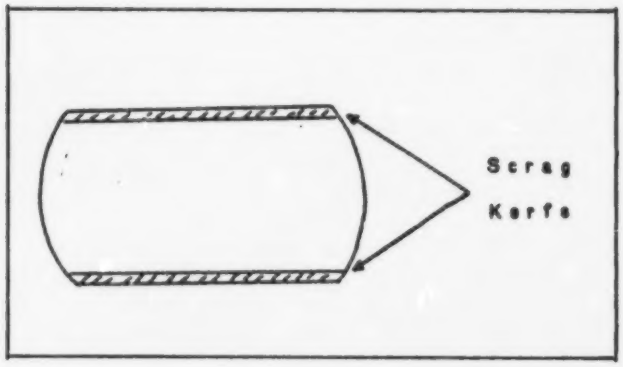


FIGURE 6: Edge cuts used for the calculation of sawdust volumes.

and secondly, by use of a gang saw:

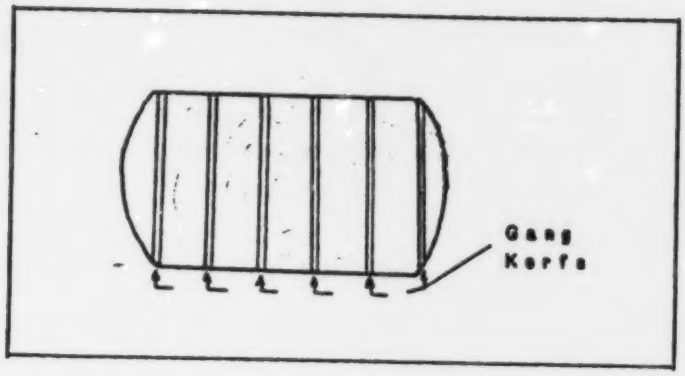


FIGURE 7: Face cuts used for calculation of sawdust volumes

The calculations are made for each thickness class; 1 in., 2 in., etc.

Edge cuts are calculated for each size using the factors illustrated below:

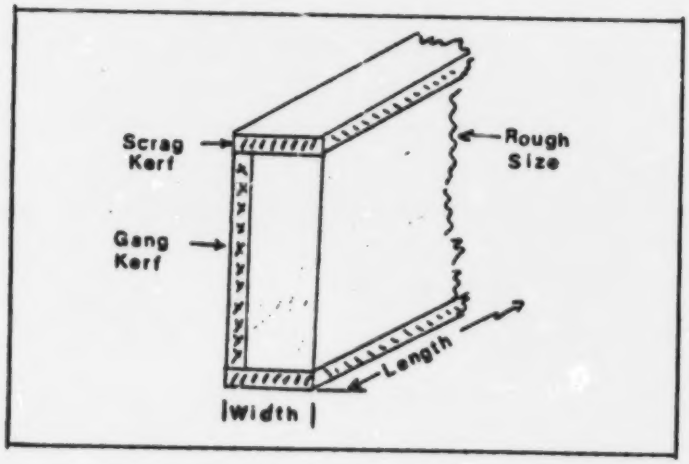


FIGURE 8: Factors considered in calculating the volume of the edge cuts.

The widths being equal to the thickness of the average size as measured by the lumber measurement sheet (or nominal size if actual measurements not available) plus an additional width for the Kerf of the gang saw.

The thickness being equal to the Scrag saw Kerf.

The length being equal to the total lineal feet of wood converted to metres (multiply feet by .305).

If a chipper head is used rather than a Scrag saw then the edge cut calculation could be omitted.

Face cuts are calculated for each size using the factors outlined below.

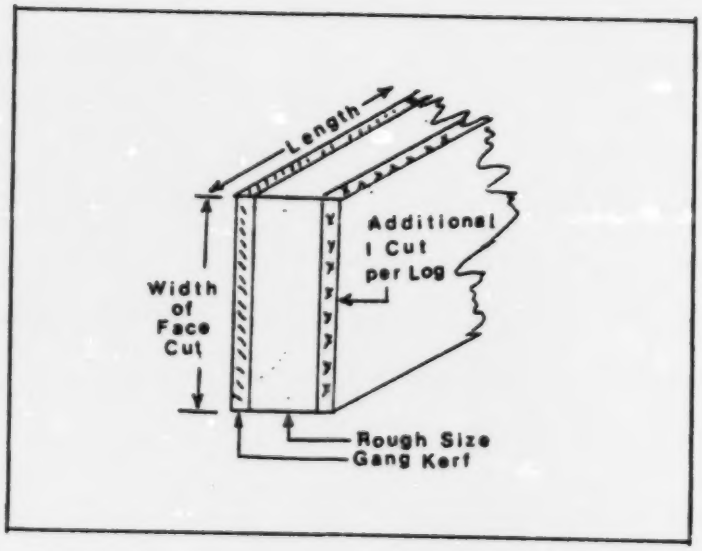


FIGURE 9: Factors considered in calculating the volume of the face cuts.

The width is equal to the average width of the boards. To obtain this width the total volume is divided by the total length (metres) to give the end area of the average piece. The end area is further divided by the average thickness (as calculated for edge) to arrive at the average width. All sizes should be in metres to compile properly (i.e. a thickness of 1 in. or 2.54 cm should be stated as 0.0254 m).

The thickness is equal to the saw Kerf of the gang saw.

The length is equal to the total length of the boards in metres (feet X 0.305).

An adjustment is made to the total to compensate for the additional cut on each log.

Boards/log = Total # boards/# of logs.

Cuts/log = Boards/logs + 1.

$$\text{Adjusted Face Volume} = \frac{\text{Cuts/log}}{\text{Boards log}} \times \text{Face Cut Volume}$$

If a resaw is being used additional face cuts may be calculated for each one-inch board using the width, length and Kerf of resaw.

The sum of the Edge cuts and Face cuts will then give the estimate of the total volume of sawdust. This volume, in turn, divided by the Net m^3 Volume (1 000X) to give the percentage.

Example of Sawdust Calculation

Net Scale (m^3 1 000X)			10 002
No. of Logs			49
No. of Boards	1"	39	
	2"	188	227

Length of Boards	Lineal Feet	Metres @ .305
1 in.	484	147.62
2 in.	2 562	781.41

Volume of Rough Lumber (m^3 1 000X)	1"	467
	2"	5 455

Saw Kerf	Scrag	5/16"	(8 mm)
	Gang	3/16"	(4.8 mm)

Thickness of Board (as per lumber measurement sheet or nominal)

1" = 2.54 cm (0.0254 m)

2" = 4.80 cm (0.0480 m)

Thickness of Cut (Board thickness + Kerf of Gang)

1" = 0.0254 + 0.0048 = 0.0302

2" = 0.0480 + 0.0048 = 0.0528

Average width of cuts (volume m^3 ÷ length in metres ÷ thickness of board)

1 in. = 0.467 - 147.62 ÷ 0.0254 = 0.1245 m (12.45 cm)

2 in. = 5.455 - 781.41 ÷ 0.0480 = 0.1454 m (14.54 cm)

Volume:

Edge Cuts (1 000X) 2 edges (thickness of cut X Scrag Kerf X length in metres)

1 in. = 2 X 0.0302 X 0.008 X 147.62 X 1 000 = 71 m^3 (1 000X)

2 in. = 2 X 0.0528 X 0.008 X 781.41 X 1 000 = 660 m^3 (1 000X)

731 m^3 (1 000X)

Face Cut (1 000X) 1 face (width of cut X Gang Kerf X length in metres)

1 in. = 1 X 0.1245 X 0.0048 X 147.62 X 1 000 = 88 m^3 (1 000X)

2 in. = 1 X 0.1454 X 0.0048 X 781.41 X 1 000 = 545 m^3 (1 000X)

633 m^3 (1 000X)

Adjustment of additional face (1 per log)

Boards/log = 227 - 49 = 4.63

Cuts/log = 4.63 + 1 = 5.63

Adjustment = $633 \times \frac{5.63}{4.63} = 769$

Total sawdust = 731 + 769 = 1 500 m^3 (1 000X)

% Sawdust = $\frac{1\ 500 \times 100}{10\ 002} = 15\%$

APPENDIX 2

ANALYSIS OF WOODCHIP DATA

In analysing the potential chip recovery from sawlogs, two approaches were studied.

1. Calculations of log breakdowns as presented by the Alberta Log Rule.

The Alberta Log Rule makes a deduction for slabs by deducting a board 2.12 inches (54 mm) thick and having a width equal to the diameter of the log. This volume is considered as woodchips. An estimate of fbm deducted as slab from a 1.2 m section is calculated in the Alberta Scaling Manual as follows.

Slab deduction = 0.273834 D

Adding the taper of 1.25 cm for every 1.2 m the fbm deduction for various lengths was calculated. This deduction can be converted to m^3 lumber equivalent by multiplying by 1.623.

The log profiles derived for the appraised disposition logged in 1981/82 were used to weigh the volume of woodchips, log scale volume and m^3 scale for the year. Average recovery factors for various diameters and for the year were calculated.

Some chipper type sawmills such as chip and saws probably convert some of the 5/16 inch allowed for sawkerf to chips. To compensate, 50% of the sawkerf volume was converted to woodchips based on the following calculations.

Log Kerf allowance 5/16 inches

Total at width per board 37/16 inches

$$\% \text{ Kerf} = (1 - \frac{32}{37}) \times 100 = 13.5\%$$

The woodchip volume was increased by adding 6.75% of the m^3 scale. Adjusted factors were calculated using these increased volumes.

TABLE 21

CALCULATION OF LUMBER AND CHIP VOLUMES
USING THE ALBERTA LOG RULE
(weighted by 1981/82 log data)

TOP DIA.	NO. OF LOGS	M3 LOG SCALE	FBM LOG SCALE	FBM/ M3	M3 LUMBER	% LUMBER	M3 WOODCHIP	% WOODCHIP	BDU/ MFBM	BDU/ M3	ADJUSTED WOODCHIP	ADJ. BDU/ MFBM	ADJ. BDU/ M3
8	16407	528	41341	78	67	12.69	224	42.42	1.913	0.150	260	2.218	0.174
10	556236	27459	3428003	125	5595	20.38	9966	36.29	1.027	0.128	11819	1.218	0.152
12	1062318	64303	9936089	155	16216	25.22	20641	32.10	0.734	0.113	24981	0.888	0.137
14	1659858	126964	22867166	180	37319	29.39	35695	28.11	0.551	0.099	44265	0.684	0.123
16	2206311	251827	51183825	203	83532	33.17	61367	24.37	0.423	0.086	78365	0.541	0.110
18	880293	134900	29418296	218	48011	35.59	29453	21.83	0.354	0.077	38559	0.463	0.101
20	1317234	253264	58163954	230	94924	37.48	50001	19.74	0.304	0.070	67096	0.407	0.094
22	504277	118312	28228103	239	46068	38.94	21311	18.01	0.267	0.064	29297	0.367	0.087
24	824344	231319	56766546	245	92643	40.05	38240	16.53	0.238	0.058	53854	0.335	0.082
26	267248	88110	22124235	251	36107	40.98	13465	15.28	0.215	0.054	19412	0.310	0.078
28	456401	175879	44865168	255	73220	41.63	24891	14.15	0.196	0.050	36763	0.289	0.074
30	133421	59221	15319555	259	25002	42.22	7815	13.20	0.180	0.047	11812	0.272	0.070
32	225744	113644	29711163	261	48489	42.67	14046	12.36	0.167	0.044	21717	0.258	0.067
34	51877	29658	7807776	263	12742	42.96	3434	11.58	0.155	0.041	5436	0.246	0.065
36	102136	65008	17234328	265	28126	43.27	7107	10.93	0.146	0.039	11495	0.236	0.062
38	21945	15946	4235210	266	6912	43.35	1635	10.25	0.136	0.036	2711	0.226	0.060
40	46931	37645	10033017	267	16374	43.50	3657	9.71	0.129	0.034	6198	0.218	0.058
42	9763	8620	2302211	267	3757	43.58	795	9.22	0.122	0.033	1377	0.211	0.056
44	18865	18202	4865614	267	7941	43.63	1596	8.77	0.116	0.031	2825	0.205	0.055
46	3906	4081	1092271	268	1783	43.69	341	8.36	0.110	0.030	616	0.199	0.053
48	8190	9454	2526373	267	4123	43.61	752	7.95	0.105	0.028	1390	0.194	0.052
50	1733	2449	644924	263	1053	43.00	182	7.43	0.100	0.026	347	0.190	0.050
52	3229	4544	1205164	265	1967	43.29	327	7.20	0.096	0.025	634	0.186	0.049
54	743	1149	300145	261	490	42.65	78	6.79	0.092	0.024	156	0.183	0.048
56	935	1500	396801	265	648	43.20	100	6.67	0.089	0.024	201	0.179	0.047
58	331	568	150150	264	245	43.13	36	6.34	0.085	0.022	74	0.175	0.046
60	399	690	184128	267	300	43.48	43	6.23	0.082	0.022	90	0.172	0.046
62	18	34	8906	262	15	44.12	2	5.88	0.079	0.021	4	0.170	0.045
64	327	812	205466	253	335	41.26	44	5.42	0.076	0.019	99	0.170	0.043
66	34	73	19186	263	31	42.47	4	5.48	0.074	0.019	9	0.164	0.043
68	68	156	40818	262	67	42.95	8	5.13	0.069	0.018	19	0.160	0.042
70	0	0	0	0	0	0.00	0	0.00	0.000	0.000	0	0.000	0.000
72	29	74	19212	260	31	41.89	4	5.41	0.074	0.019	9	0.165	0.043
74	19	53	13833	261	23	43.40	3	5.66	0.077	0.020	7	0.168	0.044
76	18	53	13572	256	22	41.51	2	3.77	0.052	0.013	6	0.145	0.037
	10381588	1846499	425352549	230	694178	37.59	347265	18.81	0.288	0.066	471904	0.392	0.090

2. Calculation of woodchip volumes employing sawmill study data.

To analyse the probable woodchip recovery, the sawmill study data in Appendix 2 was sorted by mill type to arrive at Appendix 3(b). The mill type and approximate percentage of provincial sawmill production is shown below.

Mill Code	Mill Type	% of Prov. Production
A	Circular Headsaw/gangsaw	4.2
B	Scrag saw/gang sawmill	14.0
C	Stud Mills	31.7
D	Chipper headrigs or chip 'n' saws	50.1
		100.0

Weighing the residuals from the studies by the percentage of production the following can be calculated.

WEIGHTED RECOVERY - PERCENTAGES

Mill Code	Wt. Factor	% Lumber	% Sawdust	% Shavings	% Woodchips
A	0.042	37.39	22.26	16.81	23.55
B	0.140	35.03	19.64	14.33	31.00
C	0.317	34.62	17.65	14.12	33.60
D	0.501	45.62	7.12	14.88	32.38
Weighted average		40.30	12.85	14.64	32.20

WEIGHTED RECOVERY - PRODUCTS

Mill Code	Wt. Factor	FBM/m^3	BDU/Mfbm	BDU/m^3
A	0.042	238	0.349	0.083
B	0.140	215	0.510	0.109
C	0.317	227	0.523	0.119
D	0.501	271	0.422	0.114
Weighted average		248	0.464	0.114

Using the average nominal size of a 2X6, 1 000 fbm of lumber is equivalent to 1.623 m^3 of solid wood.

With the average recovery of 233 fbm/m^3 of roundwood is required to produce a 1 000 fbm. The percentage lumber recovery can be thus calculated as follows:

$$\frac{1.623}{4.292} \times 100 = 37.81\%$$

The weighted average lumber recovery from the sawmill study data was 40.3%. To adjust the chip recovery to the average mill recovering 233 fbm/m^3, the following adjustment to the woodchip recovery is made:

$$(40.3\% - 37.81\%) + 32.20 = 34.69\%$$

This would mean a probable woodchip recovery factor of:

$$\frac{0.3469 \times 35.315}{100} = 0.123 \text{ BDU/m}^3$$

OR

$$0.123 \times 4.292 = 0.528 \text{ BDU/Mfbm.}$$

Of course this recovery can become larger if the sawkerf and shaving percentages are decreased, however, this depends upon the option of producing more lumber volume.

There is a trend towards processing smaller timber. In order to reflect this trend, a larger chip recovery than calculated above is recognized as follows.

Average chip recovery

BDU/Mfbm = 0.600

BDU/m^3 = 0.140

TABLE 22

BREAKDOWN OF PRODUCTS AND BYPRODUCTS
CALCULATED BY MILL TYPE

MILL TYPE	NET SCALE	M3 LUMBER	% LUMBER	M3 SAWDUST	% SAWDUST	M3 SHAVING	% SHAVING	M3 WOODCHIP	% WOODCHIP	BDU WOODCHIP	PLANED LUMBER	BDU/ MFBM	FBM/M3 SCALE
A	15.442	5.859	37.94	4.125	26.71	1.881	12.18	3.578	23.17	1.26	3.765	0.336	244
A	13.541	5.129	37.88	3.946	29.14	2.529	18.68	1.936	14.30	0.68	3.288	0.208	243
A	59.606	23.038	38.65	11.957	20.06	10.783	18.09	13.829	23.20	4.88	14.588	0.335	245
A	60.377	21.123	34.99	12.304	20.38	8.903	14.75	18.047	29.89	6.37	13.397	0.476	222
A	52.379	20.145	38.46	11.817	22.56	9.365	17.88	11.052	21.10	3.90	12.762	0.306	244
A	61.913	23.970	38.72	12.810	20.69	10.003	16.16	15.130	24.44	5.34	15.160	0.352	245
A	50.238	17.352	34.54	10.535	20.97	7.611	15.15	14.740	29.34	5.21	11.058	0.471	220
A	19.231	7.037	36.59	5.925	30.81	3.567	18.55	2.702	14.05	0.95	4.603	0.207	239
A	26.013	10.088	38.78	6.873	26.42	3.754	14.43	5.299	20.37	1.87	6.548	0.286	252
A	21.900	8.007	36.56	5.727	26.15	4.238	19.35	3.929	17.94	1.39	5.240	0.265	239
A	30.963	11.741	37.92	6.090	19.67	5.957	19.24	7.174	23.17	2.53	7.482	0.339	242
A	17.896	7.085	39.59	3.488	19.49	3.595	20.09	3.728	20.83	1.32	4.486	0.293	251
	429.499	160.573	37.39	95.596	22.26	72.187	16.81	101.143	23.55	35.72	102.377	0.349	238
B	34.900	11.269	32.29	7.057	20.22	6.128	17.56	10.446	29.93	3.69	7.590	0.486	217
B	122.388	64.804	52.95	26.350	21.53	4.063	3.32	27.170	22.20	9.60	30.863	0.311	252
B	51.092	18.071	35.37	11.194	21.91	6.320	12.37	15.506	30.35	5.48	11.339	0.483	222
B	45.926	15.482	33.71	10.154	22.11	5.888	12.82	14.402	31.36	5.09	9.764	0.521	213
B	41.191	13.568	32.94	8.984	21.81	5.165	12.54	13.474	32.71	4.76	8.535	0.557	207
B	69.996	24.070	34.39	17.359	24.80	11.119	15.89	17.448	24.93	6.16	15.237	0.404	218
B	72.857	23.757	32.61	16.100	22.10	11.236	15.42	21.764	29.87	7.69	14.989	0.513	206
B	39.678	11.550	29.11	7.614	19.19	5.618	14.16	14.895	37.54	5.26	7.367	0.714	186
B	75.187	28.992	38.56	16.293	21.67	12.586	16.74	17.316	23.03	6.11	18.267	0.335	243
B	72.954	28.423	38.96	15.654	21.46	12.821	17.57	16.056	22.01	5.67	17.816	0.318	244
B	45.875	13.845	30.18	8.069	17.59	5.748	12.53	18.212	39.70	6.43	8.757	0.734	191
B	75.923	27.833	36.66	16.035	21.12	12.679	16.70	19.376	25.52	6.84	17.545	0.390	231
B	66.486	22.426	33.73	13.357	20.09	11.755	17.68	18.949	28.50	6.69	14.097	0.475	212
B	72.743	22.056	30.32	13.276	18.25	9.988	13.73	27.424	37.70	9.68	13.936	0.695	192
B	72.302	24.539	33.94	13.434	18.58	10.665	14.75	23.664	32.73	8.36	15.378	0.543	213
B	87.956	26.677	30.33	16.791	19.09	12.182	13.85	32.306	36.73	11.41	16.916	0.674	192
B	82.050	23.540	28.69	9.944	12.12	11.651	14.20	36.914	44.99	13.04	14.934	0.873	182

TABLE 22 CONTINUED

BREAKDOWN OF PRODUCTS AND BYPRODUCTS
CALCULATED BY MILL TYPE

MILL TYPE	NET SCALE	M3 LUMBER	% LUMBER	M3 SAWDUST	% SAWDUST	M3 SHAVING	% SHAVING	M3 WOODCHIP	% WOODCHIP	BDU WOODCHIP	PLANED LUMBER	BDU/ MFBM	FBM/M3 SCALE
B	52.876	16.894	31.95	10.554	19.96	7.091	13.41	18.337	34.68	6.48	10.671	0.607	202
B	51.128	17.864	34.94	9.408	18.40	8.533	16.69	15.323	29.97	5.41	11.134	0.486	218
B	86.585	27.898	32.22	14.174	16.37	12.520	14.46	31.993	36.95	11.30	17.413	0.649	201
B	88.743	30.297	34.14	13.365	15.06	16.311	18.38	28.770	32.42	10.16	19.183	0.530	216
B	24.807	8.355	33.68	5.180	20.88	4.455	17.96	6.817	27.48	2.41	5.363	0.449	216
B	27.956	10.352	37.03	6.153	22.01	5.429	19.42	6.022	21.54	2.13	6.608	0.322	236
B	30.695	10.218	33.29	6.560	21.37	3.831	12.48	10.086	32.86	3.56	6.604	0.539	215
	1492.294	522.782	35.03	293.058	19.64	213.783	14.33	462.671	31.00	163.39	320.306	0.510	215
C	47.276	16.239	34.35	8.146	17.23	6.614	13.99	16.277	34.43	5.75	10.660	0.539	225
C	45.530	15.216	33.42	7.881	17.31	5.905	12.97	16.527	36.30	5.84	9.996	0.584	220
C	37.884	15.048	39.72	7.577	20.00	6.941	18.32	8.318	21.96	2.94	9.842	0.298	260
C	51.232	17.368	33.90	8.868	17.31	7.039	13.74	17.957	35.05	6.34	11.391	0.557	222
C	54.232	17.880	32.97	9.219	17.00	6.855	12.64	20.277	37.39	7.16	11.713	0.611	216
	236.154	81.751	34.62	41.692	17.65	33.354	14.12	79.357	33.60	28.02	53.602	0.523	227
D	256.406	118.870	46.36	22.205	8.66	37.922	14.79	77.409	30.19	27.34	69.453	0.394	271
D	94.427	41.189	43.62	2.767	2.93	14.277	15.12	36.194	38.33	12.78	25.635	0.499	271
	350.833	160.059	45.62	24.971	7.12	52.200	14.88	113.603	32.38	40.12	95.088	0.422	271
	2508.78	925.165	36.88	455.317	18.15	371.524	14.81	756.774	30.17	267.25	571.373	0.468	228

APPENDIX 3 (a)

SUMMARY OF LOG DATA (1978-79)

Top Diameter - five inches and over
Length - eight feet and longer
Spruce and Pine Sawlogs

		Average Per Log	
		Imperial	Metric
Logs	15,736,052		
Cubic feet	88,939,390	5.651951	0.160044
Length	189,433,128	12.038161	3.669231

Ave. Cu. ft./ft. = 0.469503
Ave. Dia. (midpoint) = 9.278027 (Ave. Dia. = $\frac{0.469503}{0.00545415}$)

Ave. Midpoint Dia. (metric) = 23.566189

Ave. Top Dia. (metric) = 21.8684

****

APPENDIX 3 (b)

SUMMARY OF LOG DATA (1979-80 Metric)

Top Diameter - 14 cm (five inches) and over
Length - 2.4 m (eight feet) and longer
Spruce and Pine Sawlogs

		Average Per Log
Logs	10 508 539	
Gross m^3	2 425 093.0921	0.230774
Length	50 445 296.8812	4.800410

Ave. m^3/m = 0.048074

Ave. Midpoint Dia. = 24.740608 cm

Ave. Top Dia. = 22.4841 cm

****

APPENDIX 3 (c)

SUMMARY OF LOG DATA (1980-81 Metric)

Top Diameter - 14 cm and over
Length - 2.4 m and longer
Spruce and Pine Sawlogs

		Average Per Log
Logs	11 392 370	
Gross m^3	2 449 188.0574	0.214985
Length	54 810 600.9139	4.811167

Ave. m^3/m = 0.044685

Ave. Midpoint Dia. = 23.853 cm

Ave. Top Dia. = 21.6396 cm

****

APPENDIX 3 (d)

SUMMARY OF LOG DATA (1981-82 Metric)

Top Diameter - (as per disposition)
Length - (All Lengths)
Spruce and Pine Sawlogs

		Average Per Log
Logs	10 084 800	
Gross m^3	1 772 671	0.176
Length	44 167 411	4.37960

Ave. m^3/m = 0.040135

Ave. Midpoint Dia. = 22.61 cm

Ave. Top Dia. = 20.64 cm

****

APPENDIX 3 (e)

SUMMARY OF LOG DATA (1982-83 Metric)

Top Diameter - (as per disposition)
Length - (all lengths)
All Spruce and Pine From Appraised Dispositions

		Average
Logs	3 507 164	
Gross m^3	631 125	0.180 m^3/log
Cull	19 249	3.05%
Length	15 036 254	4.2873 m/log

Ave. m^3/m = 0.041974

Ave. Midpoint Dia. = 23.12 cm

Ave. Top Dia. = 20.96 cm

****

APPENDIX 3 (f)

SUMMARY OF LOG DATA (1983-84 Metric)

Top Diameter - (as per disposition)
Length - (all lengths)
All Spruce and Pine From Appraised Dispositions

		Average
Logs	13 126 091	
Gross m^3	2 532 582	0.193 m3/log
Cull	81 843	3.23%
Length	57 659 746	4.3928 m/log

Ave. m^3/m = 0.043923

Ave. Midpoint Dia. = 23.64 cm

Ave. Top Dia. = 21.43 cm

****

APPENDIX 3 (g)

SUMMARY OF LOG DATA (1984-85 Metric)

Top Diameter - (as per disposition)
Length - (all lengths)
All Spruce and Pine From Appraised Dispositions

		Average
Logs	10 911 601	
Gross m^3	2 029 964	0.180 m^3/log
Cull	51 206	2.52%
Length	50 460 123	4.6244 m/log

Ave. m^3/m = 0.040229

Ave. Midpoint Dia. = 22.63 cm

Ave. Top Dia. = 20.31 cm

****

APPENDIX 5

SUMMARY OF CONVERSION FACTORS

Volume measurements:

1 m^3 = 35.315 cubic feet

Pulpwood

1 cord = 2.407 m^3 (roundwood)

1 m^3 (roundwood) = 0.416 cords
= 1.506 m^3 (stacked) rough, coniferous
= 1.280 m^3 (stacked) peeled, coniferous
= 1.795 m^3 (stacked) rough, deciduous

1 cord = 3.625 m^3 (stacked)

1 m^3 (stacked) = 0.276 cords
= 0.664 m^3 (roundwood) rough, coniferous
= 0.781 m^3 (roundwood) peeled, coniferous
= 0.557 m^3 (roundwood) rough, deciduous

Lumber

1 000 fbm = 1.623 m^3 (lumber)
= 4.292 m^3 (roundwood)

1 m^3 (roundwood) = 233 fbm
= 0.378 m^3 (lumber)

Railway Ties

Grade No. 1 Ties

1 tie = 39 fbm
= 0.106 m^3 (solid wood)
= 0.166 m^3 (roundwood equivalent)

Grade No. 2 Ties

1 tie = 30 fbm
= 0.081 m^3 (solid wood)
= 0.129 m^3 (roundwood equivalent)

Slabs

Edged slabs

1 m^3 (stacked) = 0.524 m^3 (solid wood)
= 221 fbm

Unedged slabs

1 m^3 = 0.500 m^3 (solid wood)
= 212 fbm

Lath

1 bundle = 50 pieces
= 9.375 fbm
= 0.024 m^3 solid wood

1 000 pieces = 188 fbm
= 0.442 m^3 solid wood
= 0.807 m^3 roundwood equivalent

Woodchips

(recovered from sawmill as by-product)
1 Mfbm = 0.600 BDU
1 m^3 = 0.140 BDU

Plywood

(based on 28 cm bolt average)
1 m^3 (roundwood) = 670 sq. ft. 3/8" plywood
= 21 sheets 4' X 8' plywood

Weight measurements:

1 pound = 0.454 kg
1 kilogram = 2.205 lbs.

1 ton = 0.904 tonnes or 907.2 kilograms
1 tonne = 2 204.62 lbs. or 1.102 tons

Sawlogs and Roundwood

1 m^3 (roundwood) = 866 kg (spruce and pine)
= 949 kg (birch)

Lumber

Rough, green, coniferous	2"	1 190 kg/Mfbm or 505 kg/m^3 (lumber)
	1"	1 880 kg/Mfbm or 810 kg/m^3 (lumber)
Surfaced, green, coniferous	2"	935 kg/Mfbm or 575 kg/m^3 (lumber)
Surfaced, dry, coniferous	2"	745 kg/Mfbm or 460 kg/m^3 (lumber)
	1"	755 kg/Mfbm or 480 kg/m^3 (lumber)
Surfaced, dry, deciduous	2"	680 kg/Mfbm or 420 kg/m^3 (lumber)

Woodchips

1 Bone Dry Unit (BDU) = 2 400 lbs.
= 1.089 tonnes
= 100 cubic feet (roundwood)
= 3.084 m^3 (roundwood)

1 tonne = 2.603 m^3 (roundwood)

Pulp

Unbleached Pulp

1 tonne pulp = 5.586 m^3 (roundwood) spruce
= 4.993 m^3 (roundwood) pine
= 4.431 m^3 (roundwood) aspen

Bleached Pulp

1 tonne pulp = 5.930 m^3 (roundwood) spruce
= 5.305 m^3 (roundwood) pine
= 4.712 m^3 (roundwood) aspen

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